

Mantle of animal completely covering shell, roughly papillose, vinaceous rufous above, somewhat lighter below. In the center of the mantle, above, is a rather poorly defined hexagonal, flattish area, the diameter of which is about one-fourth the length of the animal. From each of the six angles of the central area a poorly defined ridge runs to the lower part of the mantle, each ridge being ornamented with from one to three dusky spots; also in the middle of the central area, and in each of the six areas between the ridges is a single black spot (Fig. 1b).

Type, No. 1059 Los Angeles Museum, collected by Mrs. Rubie E. Sharon among marine vegetation at extreme low tide, at Anaheim Bay, Orange County, California, January 6, 1939. Paratypes in collections of Mrs. Sharon, and Mr. and Mrs. E. P. Chace. An additional alcoholic specimen in the Los Angeles Museum.

The naticoid form of this shell at once distinguishes it from *Lamellaria stearnsi*, *diegensis*, *rhombica*, or *digueti*, as well as from any other species of the group known to the writer. Of the subgenera usually placed under *Lamellaria*, it is probably closest to *Marsenina* or *Coriocella* in shell characters. The mantle, however, is not fissured.

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## ASPECTS OF DEPAUPERIZATION

BY CALVIN GOODRICH

Depauperization as it is understood by malacologists is the outward manifestation of disease, accident or malnutrition or a reaction to inimical environment. It affects individual mollusks fairly frequently, but also it sometimes involves whole colonies and races. It is so common a phenomenon that authors usually have been content with merely mentioning it as an observation or, going farther, registering it by such a specific or subspecific name as *pauperculum*. But what may be termed the symptoms of depauperization have not been defined so far as the writer can discover. It is intended here to mention those signs, indications or marks of it that have come to his attention.

The most obvious symptom is dwarfing. In the sandy regions of eastern Michigan is a form of *Polygyra albolabris* to which the varietal name *maritima* is commonly given. Outside of the damp

ravines and river banks, it is the only form of the species occurring in the areas. It is sometimes surprisingly small. Rain in the districts has a rapid run-off. Upland woods become exceedingly dry by mid-summer. So on top of hibernation, a fairly long aestivation is imposed on the snails. Lack of moisture circumscribes the season of activity and that, it would seem, brings about a reduction of whorl size. The same kind of hardship is experienced by *Aplexa hynorum* and *Lymnaea palustris* that occupy woods pools. They appear invariably to be smaller than the same species in brooks and ponds. The water of one woods pool of which I kept watch one spring lasted for only six weeks. Late in the year, living mollusks were dug from the mud that lay under the hard crust. It may be that the comparatively small size and thinness of *Sphaerium occidentale* are due to living in pools and ditches that dry up with the rise of atmospheric temperature. At the other extreme so far as habitat is concerned are those species of *Pisidium* that manage to maintain existence in the bottoms of lakes which for days or weeks contain no free oxygen. Such species of these that have been seen are small even for a genus of small bivalves. A robust form of *Lithasia obovata sordida* lives in Calfkiller River, White County, Tennessee. Above the town of Sparta and about a hundred feet from the river is a torrent of water called Wildeat Spring. It is occupied by a phase of *sordida* scarcely half the size of the stream form. A rarer mollusk of the spring is *Goniobasis edgariana*. It, too, is dwarfed. Those mountain-climbers *Goniobasis proxima* and *aterina* are possibly only stunted phases of lowland species, living under much harder conditions than the latter. Both have been seen in situations beyond the heavy currents of hill brooks, but where the spray fell. In the Great Lakes are dwarfed aspects of *Lampsilis*, *Elliptio*, *Lasmigona*, *Ligumia*, *Quadrula* and *Obovaria* which have been provided with distinctive names mainly because of their small size. Brown, Clark and Gleissner (1938) have shown that complete intergradations occur between the lake shells and shells of the same species inhabiting streams nearby. They conclude that "The degree of stunting in Lake Erie for all species studied is definitely correlated with the degree of exposure found in the habitats. The more stunted individuals were found in the more

exposed lake habitats.” The instances cited can be taken as examples of depauperization for which severe or rigorous conditions of environment are responsible. But dwarfing does occur, of course, among individuals of colonies most of the members of which can be rated as of normal size. Here other factors have acted as checks to growth. The under-developed or abnormal radula that is seen once in awhile is a clue to such an agency.

S. G. Rich (1915) records finding *Elliptio complanatus* in a pond of a granitic area of Maine the specimens of which are remarkable for the lack of nacreous material. “When fresh the shells are horny and somewhat flexible, not unlike two layers of parchment pasted together, in texture. Alcoholic material and fresh are alike easily cut with a small shears, and there is no cracking.” The measurements he gives conform with those of lake-inhabiting *complanatus*. No abnormalities of soft parts were observable, but the shape was not that common to the species. The case is perhaps more interesting as evidence of adaptability than as sign of depauperization, yet any departure from a normal state sets up a threat to extinction which is the main element involving depauperization. *Margaritana margaritifera* has offset the low percentage of calcium carbonate of the waters it inhabits by undergoing exceedingly slow growth rather than by normal growth and dependence on the epidermis as a substitute for shell material. That the Maine *E. complanatus* found by Rich has not done the same thing argues that this colony has not been long in its location. In *Vitrinizonites latissimus*, we have a land mollusk that flourishes without the usual buttressing of the epidermis. While it can hardly be called depauperate, its distribution is checked very much as if it were. Plainly, a mollusk may waver upon the border between successful adaptation and extinction through loss of some component or function which is common to its class.

In *Goniobasis*, very loose coiling appears to be a sign of depauperization. *G. acutocarinata*, although described as a species, has not been found in pure colonies. Lea, its author, had only one specimen. The shell occurs as a rare variant among *G. clavaeformis* in springs and spring branches of East Tennessee. Anthony’s *Melania pagodiformis*, synonymized with *acutocarinata* by Tryon, came from Battle Creek, a tributary of the Tennessee

River west of Chattanooga. Anthony obtained, he indicates, several specimens. The creek has been collected in by H. H. Smith, Henry van der Schalie and, on two occasions, myself. None of us obtained shells of the sort. *M. pagodiformis* is to be considered an aberrant as is also *M. torulosa*, another Anthony species of the kind. It was named from one example. The common form of *Lymnaea obrussa* in Menominee County, Michigan, is *exigua*. It is very loosely coiled, and sometimes to such an extent as to seem deformed. It lacks the robust look of *obrusa* typical. In instances of loose coiling in *Pleurocera alveare*, the aperture is very small, showing that the animal itself has been small, and in all likelihood in poor physical condition.

If the aberrant occurrence of loose coiling in freshwater gastropods suggests depauperization, it cannot be said to do so in the case of land shells, or at least some of them. *Anguispira alternata* of Lake Erie and Detroit River islands is high compared with diameter, the newer whorls dropping below the plane of the older whorls. In these localities, the species lives in the open—the moisture being sufficient to relieve the snails of the necessity of seeking shelter under logs and stones. New growth, therefore, is not made in circumscribed situations wherein tight coiling would be a measure of space economy.

Certain manifestations of the simplification of shell characters are akin to depauperization though probably not always true instances of that behavior. The dentate process in *Polygyra albolabris* seems to be present in only the healthiest colonies. It is mostly eliminated in the subspecies *maritima*, so far as specimens at hand show. The spinose forms of *Io*, the more nodulous forms of *Lithasia* and *Eurycaelon*, and the plicate-striate *Goniobasis* are, almost entirely, the inhabitants of large streams. As tributaries are invaded, the sculpture is reduced or it disappears altogether. In most cases, it is the plicate, or axial, sculpture which persists the longest. This seems natural since it is apparently the most ancient of such characters. *Campeloma decampii* W. G. Binney (*Paludina spillmanii* Lea), occurring in north Alabama, is carinate or striate on one or two early whorls. Very rarely, a faint keeling, corresponding to this sculpture, shows up among embryos of the northern *C. decisum*. There is a harking back in these cases

to *C. multilineata* and *multistriata* of the Cretaceous. *Campeloma* has undergone a simplification of shell just as its radula, by every sign, has deteriorated. The several subspecies of *Valvata tricarinata* represent modifications of the strongly keeled typical *tricarinata* rather than development from simplification to elaboration. In what remains of the original lot of *Lithasia plicata* Wetherby, there are smooth shells as well as plicate ones, and the smooth specimens are not much different from *L. obovata* of the upper Kentucky River whence the types of *plicata* came. The same sculptured shells appear among smooth forms in small streams of Tennessee. Of 151 specimens of *Goniobasis ebenum* taken in the Cumberland River at Pineville, Bell County, Kentucky, thirteen were found to be plicate. A pure colony of plicate *ebenum* occurs in the South Fork of the Cumberland in Wayne County, Kentucky. The outer lip of mature *Goniobasis livescens* of Ohio and Michigan is sinuous, but specimens taken in Niagara River just above and just below the Falls have straight lips.

Shell simplification is at times carried to such a point that anything definite in the way of character is lost. That is, a shell may have the features of shells in general, and not much else that a describing naturalist, if put to it, could swear to. So descriptions frequently are found to deal merely with size, texture, color and shape of whorls—characters that are seldom constant even in a single colony. The steps in such simplification are those observable in depauperization, and I think it might be demonstrated that the two processes are reflections more or less of each other.

#### REFERENCES

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